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ON NEW PALEOZOIC VERTEBRATA FROM ILLINOIS,
OHIO AND PENNSYLVANIA.

(*Plates I-III.*)

BY E. D. COPE.

(*Read February 5, 1897.*)

The following pages contain descriptions of new and little-known species of Fishes and Batrachia from the Catskill and Coal Measure epochs. These are based on specimens which are for the most part contained in the private collection of Mr. R. D. Lacoë, of Pittston, Pa. Mr. Lacoë's collection is in this field, and in that of the fossil plants of the region in question, one of the best in existence. I have already described and figured from it the remarkable (?) Euryptoid, *Mycterops ordinatus*,¹ from the Coal Measures of Cannelton, Beaver county, Pa., and the *Holonema rugosa* of Claypole from the Catskill of Bradford county.² In the present collection I report the first Batrachian remains found in the Pennsylvania Coal Measures and describe a new genus of Stegocephali from Cannelton (Ctenerpeton). I also note the occurrence of Glyptolepis in the United States for the first time, and by it extend the range of the Catskill fishes in Wyoming county, Pennsylvania.

The occurrence of a large species of *Cœlacanthus* in the Mazon Creek, Ill., deposit is also shown by specimens in this collection.

PISCES.

HOLOPTYCHIUS SERRULATUS sp. nov., Pl. II, Fig. 1.

That the more distinct species of *Holoptychius* can be distinguished by their scales is the opinion of those palæichthologists who have studied them. The variety of such scales which is found in the Catskill beds of Pennsylvania and New York is considerable,

¹ Cope, *American Naturalist*, 1886, p. 1029, Pl. XV, Fig. 3.

² *Proceeds. Amer. Philos. Soc.*, 1892, p. 223, Plate VII, Fig. 2.

and I have endeavored to identify among them the species of authors. The *H. granulatus* of Newberry appears to be based on an inferior side of a scale of some species, whose true characters will remain unknown until the superior face is discovered. The following species seem to be well founded, and to differ as follows:

I. Basal part of scale smooth.

 a. Ridges entirely broken up into tubercles

H. tuberculatus Newb.

 aa. Ridges partially broken into tubercles. *H. giganteus* Ag.

 aa. Ridges not broken into tubercles.

Ridges moderate, inosculating, no intermediate tubercles.

H. nobilissimus Ag.

Ridges moderate, inosculating, small tubercles between the ridges proximally.

H. dewalkei Loh.

Ridges moderate, not or little inosculating; no tubercles.

H. americanus Leidy.

Ridges moderate, parallel, no tubercles, small. *H. radiatus* Newb.

Ridges very wide with fine grooves.

H. hallii Newb.

II. Basal part of scale with rows of tubercles.

Ridges subparallel; tubercles few, in a small tract; size small....

H. flemingii Ag.

Ridges coarse, inosculating, 25-30; tubercles less numerous, in 25-30 rows; large.

H. inflexus Loh.

Ridges fine, inosculating little, 40; tubercles more numerous, in about 40 rows; large.

H. serrulatus Cope.

III. Basal part of scale with coarse radiating ridges.

Distal ridges coarse, numerous, interrupted, passing gradually into the rather fine, proximal ridges which are not cut by cross ridges; large.

H. filosus Cope.

IV. Basal part of scale with fine radiating and concentric ridges (Glyptolepis). Size smaller.

Distal ridges coarse, few, closely placed, without lines between; no radiating lines of tubercles.

H. latus Cope.

Distal ridges coarse, more numerous, closely placed, without lines between; proximal radiating lines of tubercles, forming a fan.

H. flabellatus Cope.

Distal ridges fine, with thread lines between, proximal, radiating lines of tubercles.

H. leptopterus Ag.

These species are distributed as follows :

EUROPE.	N. AMERICA.
<i>H. nobilissimus.</i>	<i>H. americanus.</i>
<i>H. giganteus.</i>	<i>H. giganteus.</i>
<i>H. dewalkei.</i>	<i>H. tuberculatus.</i>
<i>H. flemingii.</i>	<i>H. radiatus.</i>
<i>H. inflexus.</i>	<i>H. hallii.</i>
<i>H. leptopterus.</i>	<i>H. serrulatus.</i>
<i>H. paucidens.</i>	<i>H. filosus.</i>
	<i>H. flabellatus.</i>
	<i>H. latus.</i>
	<i>H. quebecensis.</i>

The *H. nobilissimus*, *H. giganteus* and *H. flemingii* are described by Agassiz in the *Poissons Fossiles*. The *H. tuberculatus*, *H. americanus*, *H. radiatus*, *H. hallii* and *H. giganteus* are described by Newberry in *The Paleozoic Fishes of N. America*. The *H. dewalkei*, *H. inflexus* and *H. flemingii* are described by Lohest in the *Ann. de la Soc. Geol. de Belgique*, t. xv, 1888. I described the *H. filosus* in the *Proceeds. Amer. Philos. Soc.*, 1892, p. 228. I now give descriptions of the *H. serrulatus*, the *H. latus*, and the *H. flabellatus*.

The *Holoptychius serrulatus* is based on a nearly perfect scale on a piece of brown argillaceous sandstone, from Mansfield, Tioga county, Pa., probably of Catskill age, although the color is rather unusual. The scale is represented by a very clean cast, of which a mould is figured in Pl. II, Fig. 2. The species is one of the large forms of the genus, the entire scale measuring about two inches in vertical diameter. In characters this scale is of the *H. flemingii* type, but the dimensions far exceed those of that species, resembling in this respect the *H. inflexus* of Lohest. It differs from that species in the more numerous, finer and less inosculating ridges of the exposed part, and in the larger batch of tubercles consisting of more numerous series, as pointed out in the analytical table. The distal ridges become more prominent near the centre of the scale, and terminate in some elevated portions which may be cut off from the remainder of the ridges, one or two of them becoming tubercles. The tubercles of the proximal part of the scale are sharply defined cones which increase in size as the series radiate from the centre towards the proximal border of the scale. The tract of tubercles extends over the entire base of the coarse ridges, and not over a part of them only as in the *H. inflexus* and is

half as wide or more, than the width of the tract of coarse ridges. In this character and in the finer and less inosculating coarse ridges it differs from the *H. inflexus*.

<i>Measurements.</i>	MM.
Vertical diameter of scale.....	46
Longitudinal diameter of distal ridged area.....	22
" " " proximal tubercular area....	11
Five coarse ridges in	5
Five rows of tubercles at base of tract in.....	4
Seven tubercles in.....	5

From the collection of Mr. R. D. Lacoe.

HOLOPTYCHIUS LATUS, sp. nov. Pl. II, Fig. 2.

Represented by the two scales from the greenish clay rock of Factoryville, Pa., said to be of Catskill age. The species probably belongs to the section Glyptolepis Ag., and is the first one found in this country. The distal part of the scale presents eight coarse ridges, which are separated by grooves narrower than themselves, and which do not inosculate. One of them appears to be interrupted. The central part of the scale is smooth, being only interrupted by the tube of the lateral line. The circumference from one side of the tract of coarse ridges to the other presents a wide band, which is primarily sculptured by fine ridges which radiate to the margin, and which are cut by concentric ridges of different degrees of coarseness, but which are coarser than the radiating lines. These characters are more exactly defined by the following:

<i>Measurements.</i>	MM.
Vertical diameter of scale	20
Transverse diameter of scale.....	17
Three distal coarse ridges.....	3
Seven proximal concentric ridges.....	3
Width of border of concentric ridges	6
Eight radiating ridges in.....	1

The scales of this species differ from all those hitherto described in the coarseness and small number of the distal ridges. Their parallel course distinguishes them from some species, and their failure to reach the center of the scale separates them from others. In size

the type of the *H. latus* is smaller than the full-sized scales of the European species thus far described.

HOLOPTYCHIUS FLABELLATUS, sp. nov. Pl. II, Fig. 3.

Established on a nearly perfect scale from a green clay lamina from the supposed Catskill of the "Narrows" at Coxton, near Pittston, Pa. The scale is in perfect preservation, the finest details of the delicate sculpture being exactly preserved.

In the coarseness and parallelism of the distal ridges the scale represents those of the *H. latus*, rather than the *H. leptopterus*. In form the scale is longer than deep, and oval in outline, while that of the *H. latus* is as deep as long, and is rounded quadrate. Whether this difference depends on the position of the scale is not yet determinable. The border of the scale from one side of the distal ridges to the other, is occupied by a broad band which is marked by concentric grooves separated by wider convex interspaces. From the proximal end of the coarse distal ridges radiates a perfectly symmetrical fan of twenty-one ridges, each composed of a series of small tubercles, which increase in size to the end of the series. This fan measures half the long diameter of the scale between the coarse ridges and the proximal border. The entire surface, except that occupied by the coarse ridges, is sculptured by delicate line ridges and grooves of equal width, from the coarse ridges to the circumference, as in the *H. plicatilis*. The coarse ridges are twelve in number, and two of them are bifurcate. They are parallel in direction.

<i>Measurements.</i>	<i>MM.</i>
Vertical diameter of scale	11
Long diameter of scale.....	14
Three distal coarse ridges.....	2
Seven proximal concentric ridges.....	1.25
Width of border of concentric ridges.....	3
Eleven radiating ridges in	1

From the collection of Mr. R. D. Lacoë.

SAGENODUS OCCIDENTALIS Newb. *Rhizodus occidentalis* Newberry.
Report of the Geological Survey of Illinois, Vol. ii, 1866, p. 19, Fig. 2.

Three species of Sagenodus have been distinguished by scales

from the Carbonic system of Ohio and Illinois by Newberry, viz.: *S. occidentalis* and *S. reticulatus* from the concretions of the Coal Measures of Mazon Creek, Illinois, and *S. quadratus* from the Coal Measures of Linton, Ohio. The collection of Mr. Lacoë contains twenty-two scales with their reverses in clay concretions from Mazon Creek, and I have recognized the two species described by Newberry from this locality in nine of them. The remaining thirteen belong to several other species which differ widely in the size, form, and sculpture of the scales, no less than six species being apparently represented. Within the limits of these there is considerable variation, largely dependent on the part of the body from which the scale has been derived. They all present a more or less reticulate or tessellate structure, and a sculpture of very fine, closely placed lines, which radiate to the free border, the latter sometimes forming the only sculpture near the latter. This tessellate structure resembles that of the existing genus *Osteoglossum*, and its Eocene representative *Dapedoglossus* Cope. Dr. A. S. Woodward refers (*Catal. Fishes B. M.*) Newberry's species to the Dipnoans genus *Sagenodus*, and the species described below may be ultimately so referred. However, no teeth of Dipnoans have been found thus far in the Mazon Creek beds, while scales are abundant. The reference then remains uncertain, and the species should be determined for identification of the bed at other localities.

The species of the Lacoë collection differ as follows:

I. Concentric lines conspicuous; tessellation and radii not conspicuous.

Scales medium to large; subround.....*S. occidentalis* Newb.

II. Concentric lines fewer, marginal; tessellation conspicuous, radiating from a center.

Scales medium to large, acuminate distad; tessellation very fine...
S. foliatus, sp. nov.

Scales small to medium, elongate, subacuminate; tessellation elongate without regular radii or concentric ridges; center at extremity.....*S. reticulatus* Newb.

Scales medium to large, parallelogrammic; tessellation radiating, radii and concentric ridges extending to free edge; center at end.....*S. conchiopsis*, sp. nov.

Scales very large, elongate, tessellation confined to center, from which issue numerous well-spaced radii*S. lacovianus*, sp. nov.

III. No concentric lines or center; a border of fine radii.

Very large, elongate, tessellation very fine....*S. magister*, sp. nov.

IV. No concentric lines or radii; tessellation extending to posterior border.

Scales deep, smaller; center submedian; tessellation of medium coarseness *S. curleianus*, sp. nov.

Of the *S. occidentalis* there are three scales (Figs. 1-2, 19-20-99), which agree well with the descriptions of Newberry. They evidently belong to a large species very distinct from the others here enumerated. I have not identified the *S. quadratus* Newb. found at Linton, O., in the Mazon Creek specimens. One scale presents a broadly truncate posterior margin, and it is even slightly concave. The size is rather large, appropriately to the *S. quadratus*, and the sculpture is strongly marked. I suspect that it is a scale from near the shoulder-girdle, and of entirely exceptional form. Newberry's type is incompletely preserved and described, and it will be necessary to secure other specimens from Linton in order for its full characterization.

SAGENODUS FOLIATUS, sp. nov. Pl. I, Fig. 1.

Founded on two scales in excellent preservation. These differ from those of all the other species here described in their elongate oval form, with subacuminate distal border. The proximal border is strongly convex. The sculpture consists, first, of a wide border of very fine radii, crossed by rather distant concentric lines; second, of a narrower band of coarser but rather close radii; and thirdly, of a rather large area of fine reticulations, of which the center marks the proximal fourth of the length of the scale. The marginal band is marked by a reticulation much coarser than that of the center.

	<i>Measurements.</i>	MM.
Diameters of scale	{ vertical	25
	longitudinal	39
Three tesserae of area		1
Width of marginal band		6.5
Type No. F. 9 and 10, Lacoe's collection ; Cotypes F. 53, 54.		

SAGENODUS RETICULATUS Newberry, *Geol. Sur. of Illinois*, iv, 1870,
p. 349, Pl. III, Fig. 9.

Pl. I, Figs. 2, 3.

I refer four scales to this species; one of them differing somewhat from the other three, a difference which may be due to difference of position. The characters in which all agree, are the very elongate form, with medium to large size, and the coarse and rather homogeneous tessellation, in which the areas partake of the elongate form of the scale. The distal border is narrowly rounded and is marked by a border of fine longitudinal striae, which are not interrupted by concentric lines or reticulations. The single scale referred to has a lobe of the distal margin which projects beyond the remaining portion, but which has the sculpture identical with that of the latter. The proximal end is rounded in all and is marked in two of the scales by a few coarse radii. Three of them are further characterized by the presence of an oblique groove near one of the long margins. In two of them this groove cuts off a lanceolate area, passing from one long margin to the distal border, which is unsymmetrical by reason of its presence; in the scale above mentioned very much so. The center is near the proximal extremity, and is not conspicuously marked. It is possible that the grooved scales belong to the lateral line, but if so, the latter must be very irregular. The diversity in the grooves leads me to suspect, however, that all of them do not belong to the lateral line. This is a large species.

Measurements.

MM.

Diameters No. 1 (groove incomplete)	{ vertical 19 longitudinal . 36
Four tesseræ transversely measured in.....	3
Diameters No. 2 (complete with groove)	{ vertical.... 14 longitudinal. 31
Three tesseræ (transversely measured) in	2

Nos. F. 175, 176; 57, 58; F. 55, 56; F. 59, 60; Lacoe collection.

Prof. Newberry, at the place above cited, includes in this species two scales of different form from those here described, and from the one which he represents at Fig. 9. I should have preferred to have retained his name for the species, to which these two scales

belong, were it not for the fact that he states in his description that the *S. reticulatus* is characterized by the elongated form. "This is best shown," he says, "in some of the smaller specimens, which are more than twice as long as broad, and spatulate in outline." The two scales represented in Figs. 13, 14, belong probably to my *S. quincunciatus*; No. 13 is, however, larger than any scale of it which I have seen.

SAGENODUS CONCHIOLEPIS, sp. nov. Pl. I, Fig. 4.

Two scales of peculiar form represent this large species. They are parallelogrammic in outline, the extremities being about equally wide and equally moderately convex. There are two features of the sculpture which are conspicuous; first, the presence of minute striæ, both radiating and concentric, and second, the extension of the tessellate area to the edge of the scale, without border of striæ only as in the last species. The *S. conchiolepis* differs also from the *S. reticulatus* in that the terminal boundaries of the area, are also concentric, giving a characteristic appearance. The sculpture, as in the *S. reticulatus*, radiates from near the proximal end, which is not marked by radii.

Measurements.

MM.

Diameters No. 1	{ vertical at middle.....	20
	{ longitudinal	42
Tesseræ, width.....		5 to 1.5
Diameters No. 2	{ vertical.....	13
	{ longitudinal.....	29

Type F. 15, 16; Cotype F. 17, 18; Lacoë collection.

SAGENODUS LACOVIANUS, sp. nov. Pl. I, Fig. 5.

A well-preserved scale indicates another species larger than the *S. conchiolepis*, and one which resembles more the *S. reticulatus*. The scale is an elongate oval with strongly convex extremities. Although one edge is damaged enough remains to show its parallelism to the opposite edge. The sculpture is also peculiar. The usual fine radiating lines are present, but there are no concentric lines, either fine or coarse, excepting a coarse one which is one-sixth the length from the distal border, and runs quite close to the long border. The areas are confined to a central tract, which extends from the proximal border over two-fifths the length from it. The space between the concentric ridge and the lateral borders is also

segmented. The remainder of the surface is marked by rather close lines, which radiate from the reticulate center to the borders, and which are rarely connected by cross lines. A coarse groove enters proximad at one-third the width and extends across the scale towards the long margin without reaching it. This reminds of the groove in the *S. reticulatus*.

<i>Measurements.</i>	<i>MM.</i>
Diameters of scale { vertical	28
longitudinal.....	57
Five interradial spaces, transversely measured, in....	4

Nos. F. 47 and F. 48, Lacoe collection.

The only species with which it is necessary to compare this one is the *S. reticulatus*. The latter is without the radiating lines seen in this species, and the scales are more contracted distally; there is also no distinct center. The size is less, but that may be individual.

Dedicated to Mr. R. D. Lacoe, to whom science is indebted for the very fine collections he has made, and to the liberality with which he has furnished them to students for research.

SAGENODUS QUINCUNCIATUS, sp. nov. *Rhizodus reticulatus* Newberry, *Geol. Sur. of Illinois*, iv, Pl. III, Figs. 13, 14.

Pl. I, Fig. 6.

Represented by six scales, two of them in mutual relation. Size moderate; form wide, one extremity broadly truncate, the other narrowed oval. No concentric lines (an exception noted later) crossing the very fine radii. Reticulation coarse, quincuncial, areas diamond-shaped, the radial septa only continuing to the truncate or distal margin; the areas continued and becoming finer to the proximal or narrowed margin. No distinct center, unless the large tessellated area be considered as such. The areas are coarser towards the long margins. There are some lines parallel with the latter, which turn inwards parallel with the truncate border and then cease. In one of the scales these lines continue inwards so far as to constitute parts of concentric lines.

<i>Measurements.</i>	<i>MM.</i>
Diameters of scale { vertical	18
longitudinal	28

Width of areas, from5 to .75

Three of the scales are smaller than the one measured. Type F. 39, 40; Cotypes 63, 64; 43, 44; 67, 68; 23, 24.

This species is figured very imperfectly by Newberry as above cited. His Fig. 13 presents a larger scale than any of this species which I have seen.

SAGENODUS BROWNIAE, sp. nov. Pl. I, Fig. 7.

Represented by a single scale in excellent preservation. It approaches the form of those of the *S. quincunciatus*, but has a widely different sculpture. Scales as deep as long with truncate undulate free margin, and broadly rounded proximal margin. Minute longitudinal and no concentric striae. Coarser sculpture, consisting of subparallel lines which radiate from a short transverse line near the proximal end to the proximal and distal margins, which are connected by transverse lines, which are not continuous with each other and hence not concentric. It follows that the areas are parallelogrammic. The cross-lines disappear near the distal margin, leaving only the radiating sutures.

This scale is wider in relation to its length than any of the species except *S. occidentalis* and *S. gurleianus*, and is more broadly rounded proximally, and more undulate distally than its ally, the *S. quincunciatus*. The areation is coarser than in any other species and of a unique pattern.

<i>Measurements.</i>	<i>MM.</i>
Diameters of scale { vertical	18
longitudinal	21
Three areas measured transversely in.....	3

Type No. F. 13, 14.

SAGENODUS MAGISTER, sp. nov. Pl. I, Fig. 8.

Founded on two scales which exceed in dimensions those of any of the species here described. They differ somewhat in form, one being slightly truncate at both extremities, while the other is more regularly rounded. I regard the former as the type, but suspect that they belong to the same species, as the sculpture agrees closely.

There is the usual minute longitudinal striaion; besides, there are no concentric lines, but a fine and irregular areolation extending over the entire surface, except in the type specimen for a short distance at the distal margin; in the other some of the coarse radii

extend to the margin. There are coarse radii at the proximal margin in the type; in the other this edge is broken away. In both there is a very coarse areation along the long borders.

<i>Measurements.</i>	<i>MM.</i>
Diameters of type { vertical	38
longitudinal	60
Diameters of areas from.	5 to 1
Diameters of F. 7 { vertical	36
longitudinal	62

Type No. F. 5, 6; Cotype F. 7, 8.

SAGENODUS GURLEIANUS, sp. nov. Pl. I, Fig. 9.

This peculiar species is represented by a single scale. It is at least as deep as long, and the entire surface is covered with reticulations. The character of the sculpture is such that I cannot orient the borders of the scale. Its general outline is that of a very obtuse-angled equilateral spherical triangle. Along one of the borders the areation is more minute than along the other two, where it is rather coarse. In a large central tract the areation is intermediate, but as it is centrally placed, it does not aid in the orientation of the scale, as to the anterior and posterior borders; while the disposition of the areas indicates which is the vertical, and which the longitudinal diameter. There are apparently none of the fine longitudinal striae usual in this genus, and there are a few concentric ones near the margin with coarse areas. The areolar septa are not regular except a few which are subradial to one of the subhorizontal margins.

<i>Measurements.</i>	<i>MM.</i>
Diameters of scale.... { vertical.	18
transverse.	17.5
Coarser areas.....	.75
Finer areas.....	.2

Type F. 21, 22. Lacoë collection.

This species is dedicated to Mr. W. F. C. Gurley, State Geologist of Illinois, to whom I am under much obligation for the opportunity of examining important material.

BATRACHIA.

CTENERPETON ALVEOLATUM, gen. et sp. nov. Pl. III, Fig. 1.

Char. gen.—Limbs present; neural spines and chevrons of caudal vertebrae fan-shaped. Ribs present, not alate. Abdomen protected by dermal scuta in series, which form chevrons directed forwards, which terminate on each side of the belly in a series of prominent, elongate and flattened scuta, which form a ledge or shelf on each side.

This genus is founded on a specimen on a block of coal shale which is so broken that the head is wanting, and no thoracic plates are preserved, although a considerable part of the right fore limb is present. A trace of bones of a hind limb appears, and it is probable that these members were present, but of small size. The affinities of *Ctenerpeton* are with *Oëstocephalus*, *Ptyonius* and *Urocordylus*, as indicated by the characteristic caudal vertebrae. It differs from the first two in the robust scales which protect the belly, and from all three in the presence of an external series of longer flat scales, which form a prominent border, perhaps more or less free, on each side. These resemble the closely placed teeth of a coarse comb, and give the name to the genus. I have not observed this character in any other genus of *Stegocephalia*.

Char. specif.—Each abdominal dermosseous rod consisting of three segments; the median, which forms the angle of the chevron, the intermediate, which is long and slender, and the marginal, which differs in form from the others. It is wider at the base, and is curved gently backwards, terminating in a gradually contracted obtuse apex. It is marked with delicate grooves which run out on the posterior margin, and on the extremity. The anterior edge is slightly overlapped by the posterior edge of the plate immediately preceding. The anterior plates of the external series are short and obtuse. The posterior edge of the rods of the median and intermediate series is impressed by a single series of small pits like the shallow alveoli of closely placed small teeth. The neural fans of the caudal vertebrae are considerably wider than the hæmal fans, and are divided nearly to the base by a shallow groove, which is not present on the hæmal fan. The fans are of about the same length, and about twice as long as the body of a vertebra. The marginal portion is marked with ten or a dozen short longitudinal grooves, which cut the truncate edge.

The ulna or radius is short, and there is no indication of osseous carpus. The digits are long and slender, and parts of four are preserved. The first and second phalanges are slender, subequal, and a little shorter than the metacarpal. The species had a short leg and a long foot. The only trace of posterior limb is a bone (perhaps both bones) of the leg. This is quite short, and in appropriate proportion to the fore leg, but the piece is too obscure for positive determination.

The general proportions are salamandrine with indications of the long tail which characterizes the group of which *Urocordylus* Hux. is the type.

Measurements. MM.

Width of belly at middle.....	28
Length of median rod of ventral armature.....	6
" " intermediate rod of ventral armature....	6
Width " " " " " "....	1
Length " external " " " "....	9
Width " " " " "....	2
Length " (?) ulna.....	6.5
" " metacarpal	5
" " phalange i.....	3
" " " ii.....	2.5
" " (?) tibia	5.5
" " a caudal vertebra, body.....	4.5
" " " " neural spine	8
" " " " " haemal spine.....	7

From the Coal Measures of Cannelton, Pa. ; from the collection of Mr. R. D. Lacoë.

This interesting batrachian is about the size of the *Oëstocephalus remex*, but it appears to have had a lateral crest on each side bordering the abdomen, which is wanting in that and all other forms of the subclass Stegocephalia known to me. The lateral rod-plates of the abdominal armature look as though they were in life closely invested by the integument, or even projecting more or less from it. The forms of the abdominal rods and their alveoli are different from anything in the order known thus far.

CERATERPETON TENUICORNE Cope, *Report of the Geological Survey of Ohio*, "II. Paleontology," 1874, p. 372, Pl. XLII, Fig. 2 (by error on plate *C. recticorne*).

Pl. III, Fig. 2.

A partially preserved specimen of this species occurs in Mr. Lacoe's collection. It includes not only the head but the vertebral column as far as the caudal series exclusive, in bad preservation; part of the thoracic buckler and the greater part of the right hind leg and foot. As this species has been thus far known from a skull only, this specimen is very useful.

The slate is so split that the greater part of the surface of the skull is concealed in one of the slabs. On one of them, however, the presence of rows of fossæ is evident on the dentary and squamosal bones. The latter are convex outwards as in the type. The horns are placed wide apart and differ from those of the type in being a little incurved to the acute apex. The lateral pectoral shield exhibits a sculpture of radiating lines of small fossæ. There are small equal teeth on the premaxillary bone. The orbits are in the anterior half of the skull, and the nostrils and pineal foramen are distinct. The posterior foot is nearly equal in length to the leg, and the slender digits are four and probably five in number.

The accompanying measurements give a good idea of the proportions of this species.

<i>Measurements.</i>	<i>MM.</i>
Length of head to occiput, about.....	16
Greatest width of head.....	20
Length of horn from base	7
" " skull to line connecting posterior border of orbits.....	8
" " orbit.	3
Interorbital width.	3.5
Length of vertebral column to femur.	33
" " femur	5.5
" " lower leg	3
" " second digit (not complete)	7
" " metatarsal of do.	2
" " phalange i "	1.6
" " phalange ii "	1.5

This is the smallest species of the genus. It differs besides from the *C. punctolineatum* in the smoothness and acuteness of its horns, and in the weaker sculpture, where visible. It has the orbits more anterior and the horns shorter than in the still larger *C. divaricatum*.¹ The specimen shows that in this species, and probably in the others referred by me to this genus, both limbs are present; that the thoracic buckler and ribs are present, and that the spines of the vertebræ, though wide, are not sculptured. The digits are long and were probably connected by a natatory web. The block on which the specimen lies, contains several scales of fishes of the genus *Cœlacanthus*. From Cannelton, Pa., Mr. R. D. Lacoe.

SAUROPLEURA LATITHORAX, sp. nov. Pl. III, Fig. 4.

Represented by the anterior half of the animal, with the skull, on a block of coal shale from Linton, Ohio. The superior aspect of the ventral armature and of the thoracic shields is displayed, with the superior surface of the skull. The vertebral column is therefore wanting, but a number of ribs are preserved, as are also parts of both anterior limbs. Hind limbs wanting.

In the characters of its ventral armature, ribs and extremities, this species agrees with the type of the genus *Sauropleura*, *S. digitata* Cope. In the character of the skull, thoracic and ventral armature, and limbs it agrees with the genus *Colosteus* Cope. It is probable that the latter name must be regarded as a synonym of *Sauropleura* (as I have suggested in the paleontology of the *Geol. Survey of Ohio*, 1874, p. 406), although further material will be necessary to determine this point positively. In any case it may be assumed that *Sauropleura* had a thoracic armature from marks on the original specimen, and this is the only character in which it was supposed to differ from *Colosteus*, where it is present.

The ventral armature consists of longitudinal series of short scales, which series form chevrons directed forwards. The median scales are rounded in front on the superior side, viewed from above. The thoracic shields are rather wide for their length. The inter-clavicle (? *præsternum*) is rounded posteriorly, with a regularly oval outline, and the width is subequal for a distance anteriorly equal to the width. Each of the clavicles is as wide as the inter-clavicle posteriorly. The anterior extremities of all are concealed in the matrix, and the sculpture cannot be made out, as only the su-

¹Cope,

rior surface is visible. The interclavicle displays a low median longitudinal keel upwards.

The tympanic notch of the skull is feeble if present; it is quite possibly absent, as in the genus *Acheloma*. The muzzle is broadly rounded. The orbits are rather large, and the posterior borders fall a little behind the line which divides the length of the skull into two equal parts. The frontal is excluded from the supraorbital border by the large postfrontal. The postorbital is a longitudinal oval, acuminating to a point posteriorly. The cranial bones are honeycombed with fossæ, which are considerably wider than the diameter of the intervening ridges. The fossæ are generally elongate in a direction radial from the centre of the bone to which they belong. There is a long tooth near the extremity of the dentary bone. Most of the remaining teeth are concealed, but some very small ones on the premaxillary and maxillary bones are visible, and parts of some larger maxillary teeth appear below the posterior part of the orbit. The bases of the teeth are coarsely incised grooved, *i. e.*, the surface is inflected.

The legs are robust and the digits rather slender. The only ungual phalange preserved is slender, acute, and slightly curved, like that of many lizards. The humerus is robust and considerably expanded at the extremities. The ulna and radius are of usual proportions, and about three-fifths the length of the humerus. The metacarpals and phalanges are slender. No osseous carpus. Four digits are preserved; whether there is another cannot be ascertained. The ribs are long, rather slender, and not alate.

Measurements.

MM.

Length of skull to occipital condyles.....	46
" " " " table, posterior border.	35
Width " " at angles of mandible.....	86
Length " " from posterior border to orbit (axial)	26
" " orbit.	15
Width " " 	11
" " interorbital space.....	17
Length " " long mandibular tooth	6
Width " " interclavicle above.....	23
" " clavicle above (greatest).....	19
Five abdominal scales in oblique line.....	10
Length of humerus.....	20

<i>Measurements.</i>	MM.
Length of ulna.....	11
" " first finger, total.....	15.5
" " " metacarpal.....	6.5
" " " " phalange i	5
" " " " claw	4

The inequality of the lengths of the teeth with long ones anteriorly and medially, is what is seen in the type of *Colosteus*, *C. scutellatus* Newb., and in *Anisodexis* Cope. The lower jaw of the species from Linton which I called *A. enchodus* is not longer than that of the present species, if as long; but it is much more robust, and the elongate teeth are much longer, relatively and absolutely. It may belong to the same genus. As compared with the *Sauroplesura* (*Colosteus*) *scutellata*, this species differs in having a median V-shaped series of abdominal scales, and in the more slender digits. From the two other species referred to *Colosteus*, on the strength of thoracic scuta, this species differs, in the rounded posterior outline. In those species (*C. foveatus* and *C. pauciradiatus*) the posterior borders are sharply convergent to an obtuse angle. As compared with *Sauroplesura digitata* Cope, this species has relatively a much shorter forearm. In that species the ulna is five-sixths the length of the humerus, and the digits are less slender than in the *S. latithorax*.

From the collection of Mr. R. D. Lacoe, to whom I owe the opportunity of studying the unique specimen.

REPTILIA.

ISODECTES PUNCTULATUS Cope, *American Naturalist*, 1896, p. 303.
Tuditanus punctulatus, *Trans. Amer. Philos. Soc.*, 1874; *Geol. Survey of Ohio*, ii, 1874, p. 392, Pl. xxxiv, Fig. 1 (*Tuditanus longipes* in explanation, by error).

Pl. III, Fig. 3.

A collection from Linton, Jefferson county, Ohio, obtained from Mr. Samuel Houston, contains the greater part of the skeleton of what I suppose is this species. The head, scapular arch and one fore limb are lost. The remainder agrees very well with the typical specimen which was obtained by Dr. Newberry from the same locality and horizon.

There are eighteen dorsal and twenty-three caudal vertebræ, and parts or wholes of twenty-two dorsal and three caudal ribs, preserved. The vertebral bodies are amphiplatyan or amphicelous, but which, is not readily determined. Where the centra are split, an indication of notochordal canal is visible, but the impression may be that of the external right face of the centrum, and not that of the cast of that canal. Most of the centra expose the left side, displaying low and contracted neural spines on the lumbar region, and none on the dorsal. There are two sizes of caudal centra, a longer and a shorter. Where these occur in pairs they might be supposed to be the halves of a divided centrum, such as occur in the Lacertilia, but several of them are single, and in place. No trace of chevrons is to be seen. The ribs are slender, not alate, and recurved. The caudal ribs are shorter and more strongly recurved. The sacrum and pelvis are too much obscured for description.

The posterior limbs and feet are the most interesting part of this specimen. The femur is moderate, with expanded extremities, the distal divided by a popliteal groove. The tibia has the usual triangular head and contracted distal end, and has a straight shaft. The fibula is slightly curved, the interosseous border being strongly concave, and the distal end is oblique, and is wider than the proximal. The tarsus includes but two elements in the proximal series, of which the internal (intermedium all or in part) articulates with both tibia and fibula. The fibulare is a little the larger, and has a longer distal articular border. Distad of these there are six elements, one opposite each metatarsal, except the fifth, which has two. If we call the internal No. 1, and the external No. 6, they are arranged in the order of size as follows, beginning with the smallest, 6-3-1-5-2-4. No. 1 is considerably proximad of the others, as is the case with some existing salamanders. No. 3 is separated from contact with the proximal elements, by the large No. 2, which thus has the position of *centrale carpi*, but which gives attachment to the second metacarpal. The subdiscoid No. 4 articulates with both astragalus and calcaneum, but most extensively with the calcaneum. This tarsus is quite regular, and every bone is in place. That of the opposite side is turned over on the leg, and the astragalus is missing.

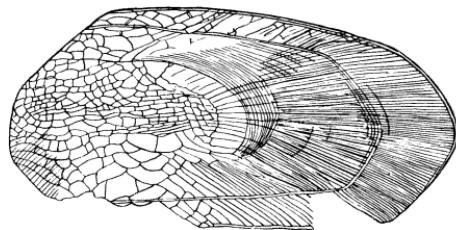
The posterior digits are long and slender, and of various lengths, although the metatarsals are of subequal length. The first and

fifth digits are the only ones with all the phalanges preserved. These number two and four respectively, with a possible doubt as to the first digit. The other toes are represented by the following numbers of phalanges: second, 3; third, 3; fourth, 5. Enough remains of the manus to show that there were at least four digits, composed of segments rather shorter than those of the pes. Three carpals remain, perhaps *centrale*, and *c. i* and *ii*; *c. i* is proximad to *c. ii*, and on the inner side of the *centrale*.

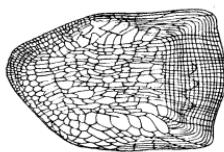
As a result it appears that the tarsus is very different from that of the *Pelycosauria*. How nearly it approximates the other *Cotylosauria* it will be my object to show shortly. It is primitive and only lacks identity with the batrachian tarsus in the absence or fusion of the *tibiale*.

<i>Measurements.</i>	MM.
Length of specimen.....	128
Expanse of ribs.....	18
Length of rib, on curve.....	14
" " centrum of fifth vertebra anterior to sacrum	4
Depth " do, with arch.....	4
Length " femur	15
Distal width of do.....	4
Length of tibia.....	7
Width " head of do	3
" " distal end of fibula.....	3.5
" " tarsus	6
Length " metatarsal iv	4.5
" " phalange i of digit iv.....	4
" " " ii " "	3.5
" " " iii " "	3.5
" " digit v, with metatarsal	16
" " median caudal vertebra.....	3

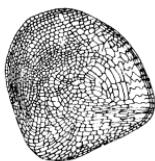
This specimen is of importance as pertaining to the oldest known reptile, and the only one which has been thus far positively identified from the Coal Measures. I announced this identification in the *American Naturalist*, 1896, p. 303.



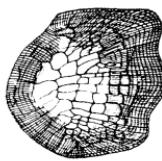
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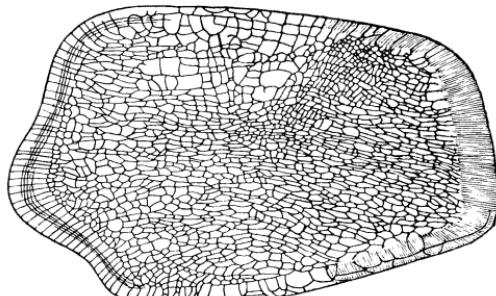
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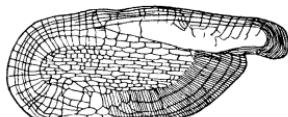
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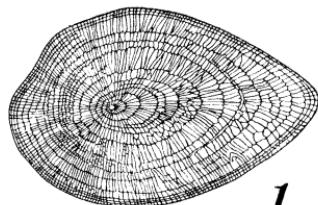
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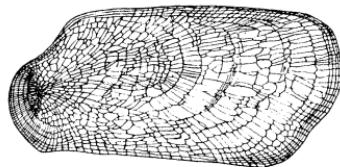
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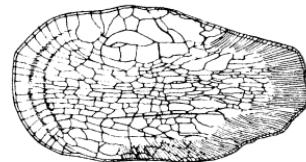
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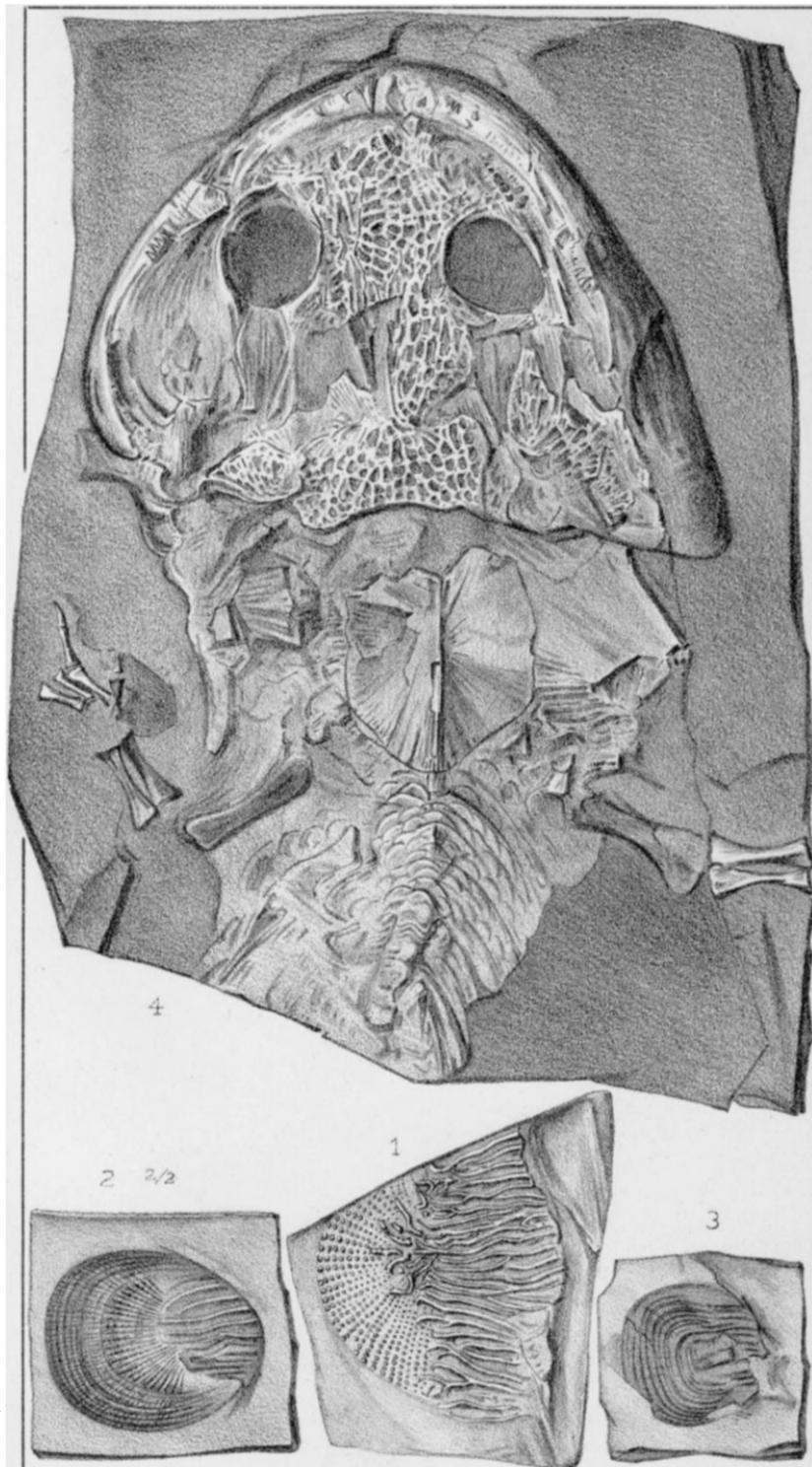
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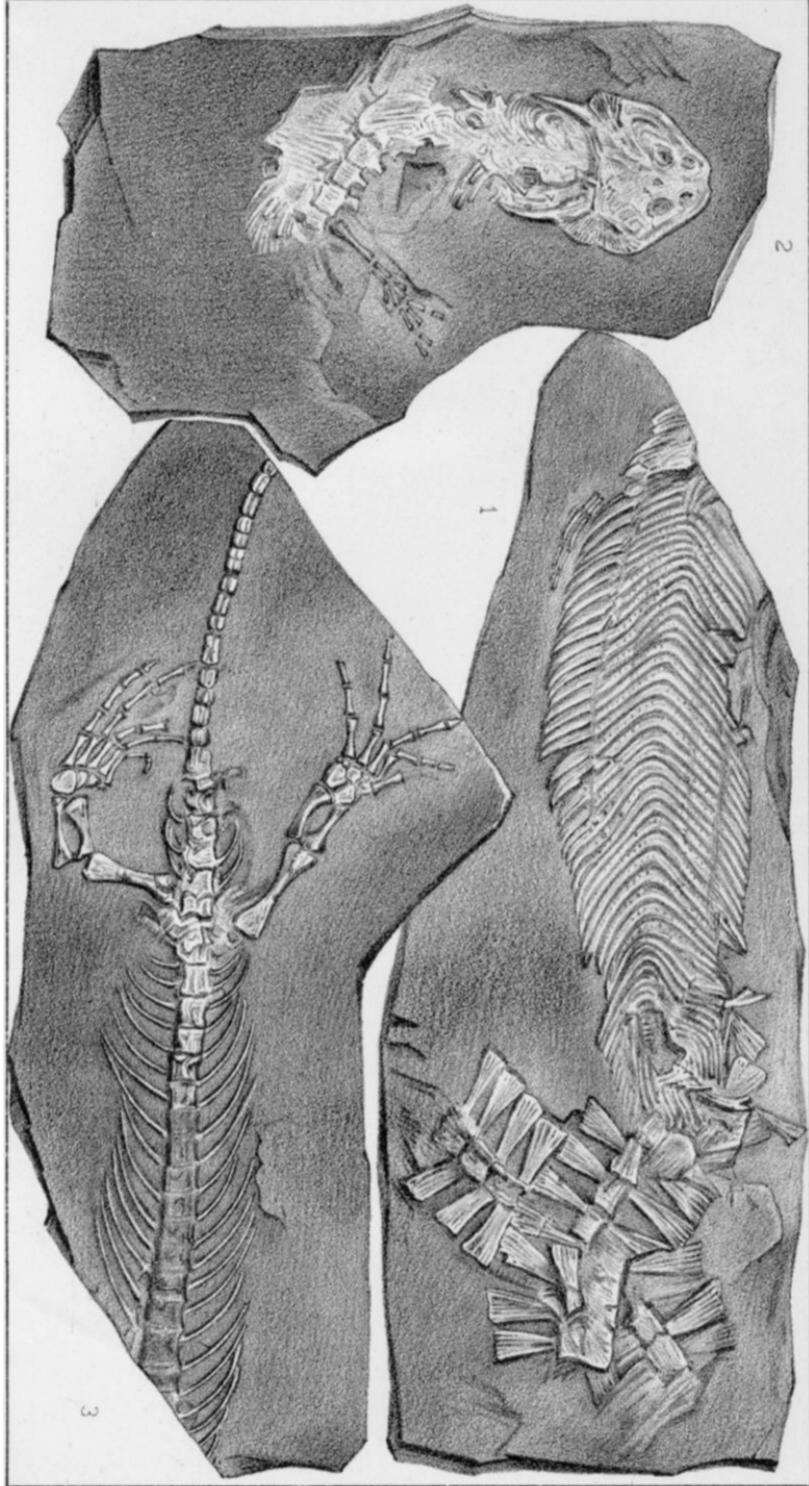
4



2

1-3. Scales of *HOLOPTYCHIUS*. 4. *SAUROPLEURA LATITHORAX*.

1. *CTENERPETON FOVEOLATUM*. 2. *CERATERPETON TENUICORNE*. 3. *ISODECTES PUNCTULATUS*.



EXPLANATION OF PLATES.

PLATE I.

Scales of *Sagenodus* from the Coal Measures of Mazon Creek, Illinois, natural size.

Fig. 1. *S. foliatus* Cope type; 2-3. *S. reticulatus* Newb.; 4. *S. concholepis* Cope type; 5. *S. lacovianus* Cope type; 6. *S. quincunciatus* Cope type; 7. *S. browniae* Cope type; 8. *S. magister* Cope type; 9. *S. gurleianus* Cope type.

PLATE II.

Figs. 1-3. Scales of *Holoptychius*, nat. size, except Fig. 2×2.

Fig. 1. *H. serrulatus* Cope type; 2. *H. latus* Cope type; 3. *H. flabellatus* Cope type.

Fig. 4. *Sauropleuria latithorax* Cope type, natural size.

PLATE III.

Fig. 1. *Ctenerpeton foveolatum* Cope, from below, natural size; 2. *Ceraterpeton tenuicorne* Cope, from above, natural size; 3. *Iso-dectes punctulatus* Cope, natural size.

[The Secretaries deem it proper to state that when the proofs of the plates of this paper were taken to Prof. Cope he was too ill to examine them, and owing to his subsequent death they have been compelled to print the plates as drawn, without the benefit of his correction.]